VAPOR PRESSURE DEFICIT (K Pa)
VERSUS AIR TEMPERATURE (^{o}F)
AND RELATIVE HUMITITY (%)

Air Temperature (TA)	Relative Humidity				
	0.00	20.00	40.00	60.00	80.00
50	1.23	0.98	0.74	0.49	0.25
60	1.77	1.41	1.06	0.71	0.35
70	2.50	2.00	1.50	1.00	0.50
80	3.49	2.80	2.10	1.40	0.70
90	4.81	3.85	2.89	1.93	0.96
100	6.54	5.24	3.93	2.62	1.31
110	8.79	7.03	5.27	3.52	1.76

Equations for calculating saturated vapor pressure are:

1. If TA is in ^{o}F:

$$VPs = 0.61078 \times \exp\left[\frac{9.5941 \times TA - 307.0113}{0.5555 \times TA + 219.5222}\right]$$

2. If TA is in ^{o}C:

$$VPs = 0.61078 \times \exp\left[\frac{17.2693882 \times TA}{TA + 237.3}\right] \quad (KPA)$$

Vapor pressure deficit is calculated as:

VPD = Vps x (1-RH/100), when RH is relative humidity (%)

The slope of VPS at a given Temperature is:

$$VPs\left[\frac{4098.02582}{(TA + 237.3)^2}\right] \quad (KPa/C)$$

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 5 CLS
 10 REM CIMIS DEWPOINT CALCULATIONS
 20 PRINT "INPUT AIR TEMPERATURE (C)"
 30 INPUT TA
 40 PRINT "INPUT RELATIVE HUMIDITY (%)"
 50 INPUT RH
 60 PRINT "INPUT ALTITUDE (METERS)"
 70 INPUT Z
 80 REM
 90 REM P=BAROMETRIC PRESSURE (MILLIBARS)
100 P=1013-.1152*Z+5.44E-06*Z^2
110 REM FOR TEST PURPOSES, SET P=1000
120 REM P=1000
130 REM ES=SATURATED VAPOR PRESSURE (MILLIBARS) OVER WATER
140 IF TA>=0 THEN ES=6.108*EXP(17.27#*TA/(TA+237.3))
150 IF TA<0 THEN ES=6.108*EXP(21.875*TA/(TA+265.5))
160 REM E=ACTUAL VAPOR PRESSURE (MILLIBARS)
170 E=(RH/100)*ES
180 REM B=INTERMEDIATE CALCULATION
190 B=LOG(E/6.108)/17.27
200 REM DEWP=DEWPOINT (C)
210 DEWP=(237.3*B)/(1-B):DEWP=(INT(DEWP*10+.5))/10
215 PRINT "                                        PURPOSE"
220 PRINT "DEWPOINT (C)=";DEWP;"  TEMPERATURE FOR FOG/CONDENSATION"
230 REM ************************************************************
240 REM NOW CALCULATE WET-BULB
250 INC=10
260 WB=DEWP
270 REM CALCULATE WET-BULB TEMPERATURE
280 REM WB=WET-BULB TEMP (C)  (MUST BE ITERATED)
290 EW=6.108*EXP((17.27*WB/(WB+237.3)))
300 EP=EW-(.00066*(1+.00115*WB)*(TA-WB)*P)
310 IF EP<E THEN WB=WB+INC:GOTO 280
320 WB=WB-INC:INC=INC/10
330 IF INC>=.001 THEN GOTO 280
335 WB=(INT(WB*10+.5))/10
340 PRINT "WET-BULB     = ";WB;" APPROXIMATE TEMP. OF WET LEAVES (AT NIGHT)"
350 REM CALCULATE THE FROST-POINT
360 REM F=FROST-POINT
370 I=LOG(E/6.108)/21.875
380 FP=(265.5*I)/(1-I)
385 FP=(INT(FP*10+.5))/10
390 IF DEWP<0 THEN PRINT "FROST-POINT =";FP;
391 IF DEWP<0 THEN PRINT"  CONDENSATION POINT FOR BELOW FREEZING AIR"
400 REM CALCULATE FROST-BULB TEMPERATURE
410 REM FB=FROST-BULB TEMPERATURE
420 FB=FP
430 INC=10
440 REM
450 REM EU=SATURATED VAPOR PRESSURE (MILLIBARS) OVER ICE
460 EU=6.1078*EXP((21.875*FB)/(FB+265.5))
470 EP=EU-.00066*(1+.00115*FB)*(TA-FB)*P
480 IF EP<E THEN FB=FB+INC:GOTO 440
490 IF EP>=E THEN FB=FB-INC:INC=INC/10
500 IF INC>=.001 THEN GOTO 440
505 FB=(INT(FB*10+.5))/10
510 IF FB<0 THEN PRINT "FROST-BULB  =  ";FB;"  APPROX. TEMP OF FROSTED PLANTS
511 PRINT :PRINT:PRINT:
512 PRINT "press 'Q' to quit/ any other key if continue'
513 A$=INKEY$:IF A$="" THEN 513
514 IF A$="q" OR A$="Q" THEN CLS:SYSTEM
515 PRINT:PRINT:PRINT
516 CLS
520 GOTO 10
```

altitude = 112 M

Table 3. Sample calculation from inputs of air temperature and wet-bulb temperature using a barometric pressure of 1,000 mb. Small differences in calculated values result from input of different sets of parameters because of rounding errors

Air temp. °C	Wet-bulb temp. °C	Rel. humid. (%)	Dew-pt. temp. °C	Sat. vap. press. (mb)	Vapor press. (mb)	Frost-pt. temp. (°C)	Frost-bulb temp. (°C)
40	40	100.0	40.0	73.76	73.76		
40	30	48.3	27.0	73.76	35.60		
40	20	13.4	6.8	73.76	9.88		
20	20	100.0	20.0	23.38	23.38		
20	10	24.0	−1.2	23.38	5.60	−1.0	
10	10	100.0	10.0	12.28	12.28		
10	5	44.0	−1.7	12.28	5.40	−1.5	
0	0	100.0	0.0	6.11	6.11		
0	−2	64.8	−5.8	6.11	3.96	−5.2	−1.9
0	−4	31.3	−14.9	6.11	1.91	−13.4	−3.8

The wet-bulb temperature is also used by engineers and architects to determine heating and cooling requirements for structures. Wet-bulb temperature is not typically archived into climatological records, so conversion from climatological records of relative humidity or dew-point temperature is useful.

Often there is interest by plant pathologists to know the temperature when water vapor will begin to condense as dew onto an object or plant as it cools. The phase change is likely to occur if the temperature of the object or plant is at or below the dew-point temperature. Dew-point temperature can be calculated from psychrometric or relative humidity and temperature observations. For example, if the air temperature is 20°C and the relative humidity is 50%, the dew-point temperature is 9.3°C. Using the same air temperature and a wet-bulb temperature of 15°C, the dew-point temperature is 11.6°C.

Many private advisors, growers, and agricultural researchers use hygrothermographs to obtain the temperature and relative humidity. Another use for the conversion program is to check hygrothermograph calibration using a psychrometer. Any conversion to or from psychrometric data requires an input of barometric pressure. The authors have observed people using tabular conversions from psychrometric measurements to relative humidity with a table for the wrong elevation. In one case a 6% relative humidity error was indicated when the hygrothermograph was actually calibrated correctly. In that particular instance a table for a 6,000-ft elevation was used at a 200-ft elevation. Examples of the conversion for several elevations are given in Table 1.

Many equations used to estimate evapotranspiration employ the vapor pressure deficit, which is calculated as the saturation vapor pressure evaluated at the air temperature minus the actual vapor pressure. The vapor pressure deficit can be calculated from psychrometric readings, the dew-point temperature, or relative humidity, using the computer program. For example, if the air and dew-point temperatures are 30°C and 20°C, respectively, the resulting saturation vapor pressure is 42 mb and the vapor pressure is 23 mb. The vapor pressure deficit is 19 mb. Given the same air temperature and a wet-bulb temperature of 23°C or a relative humidity of 55%, the vapor pressure deficit still calculates to 19 mb.

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References

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5 CLS
10 REM CIMIS DEWPOINT CALCULATIONS
20 PRINT "INPUT AIR TEMPERATURE (C)"
30 INPUT TA
40 PRINT "INPUT RELATIVE HUMIDITY (%)"
50 INPUT RH
60 PRINT "INPUT ALTITUDE (METERS)"
70 INPUT Z
80 REM
90 REM P=BAROMETRIC PRESSURE (MILLIBARS)
100 P=1013-.1152*Z+5.44E-06*Z^2
110 REM FOR TEST PURPOSES, SET P=1000
120 REM P=1000
130 REM ES=SATURATED VAPOR PRESSURE (MILLIBARS) OVER WATER
140 IF TA>=0 THEN ES=6.108*EXP(17.27#*TA/(TA+237.3))
150 IF TA<0 THEN ES=6.108*EXP(21.875*TA/(TA+265.5))
160 REM E=ACTUAL VAPOR PRESSURE (MILLIBARS)
170 E=(RH/100)*ES
180 REM B=INTERMEDIATE CALCULATION
190 B=LOG(E/6.108)/17.27
200 REM DEWP=DEWPOINT (C)
210 DEWP=(237.3*B)/(1-B):DEWP=(INT(DEWP*10+.5))/10
215 PRINT "                                        PURPOSE"
220 PRINT "DEWPOINT (C)=";DEWP;"  TEMPERATURE FOR FOG/CONDENSATION
230 REM ************************************************
240 REM NOW CALCULATE WET-BULB
250 INC=10
260 WB=DEWP
270 REM CALCULATE WET-BULB TEMPERATURE
280 REM WB=WET-BULB TEMP (C)  (MUST BE ITERATED)
290 EW=6.108*EXP((17.27*WB/(WB+237.3)))
300 EP=EW-(.00066*(1+.00115*WB)*(TA-WB)*P)
310 IF EP<E THEN WB=WB+INC:GOTO 280
320 WB=WB-INC:INC=INC/10
330 IF INC>=.001 THEN GOTO 280
335 WB=(INT(WB*10+.5))/10
340 PRINT "WET-BULB    = ";WB;" APPROXIMATE TEMP. OF WET LEAVES (A
350 REM CALCULATE THE FROST-POINT
360 REM F=FROST-POINT
370 I=LOG(E/6.108)/21.875
380 FP=(265.5*I)/(1-I)
385 FP=(INT(FP*10+.5))/10
390 IF DEWP<0 THEN PRINT "FROST-POINT =";FP;
391 IF DEWP<0 THEN PRINT"  CONDENSATION POINT FOR BELOW FREEZING A
400 REM CALCULATE FROST-BULB TEMPERATURE
410 REM FB=FROST-BULB TEMPERATURE
420 FB=FP
430 INC=10
440 REM
450 REM EU=SATURATED VAPOR PRESSURE (MILLIBARS) OVER ICE
460 EU=6.1078*EXP((21.875*FB)/(FB+265.5))
470 EP=EU-.00066*((1+.00115*FB)*(TA-FB)*P)
480 IF EP<E THEN FB=FB+INC:GOTO 440
490 IF EP>=E THEN FB=FB-INC:INC=INC/10
500 IF INC>=.001 THEN GOTO 440
505 FB=(INT(FB*10+.5))/10
510 IF FB<0 THEN PRINT "FROST-BULB  = ";FB;"  APPROX. TEMP OF FROS
511 PRINT :PRINT:PRINT:
512 PRINT "press 'Q' to quit/ any other key to continue"
513 A$=INKEY$:IF A$="" THEN 513
514 IF A$="q" OR A$="Q" THEN CLS:SYSTEM
515 PRINT:PRINT:PRINT
516 CLS
```

```
10 PRINT "INPUT WET BULB TEMP"
15 INPUT TW
20 PRINT "INPUT DRY BULB TEMP"
25 INPUT TD
30 G=64.549+0.0647*TD
40 E1=610.78*EXP((17.2693883*TD)/(TD+237.3))
50 E2=610.78*EXP((17.2693882*TW)/(TW+237.3))
60 E3=E2-G*(1+1.15E-3*TW)*(TD-TW)
70 VPD=E1-E3
75 VPD=VPD/1000
80 RH=100*(E3/E1)
90 PRINT "VPD = ";VPD;"    RH=";RH
100 GOTO 10
```

```
10 PRINT "INPUT WET BULB TEMP (°C)"
15 INPUT TW
20 PRINT "INPUT DRY BULB TEMP (°C)"
25 INPUT TD
30 G=(64.549)+0.0647*TD
40 E1=610.78*EXP((17.2693883*TD)/(TD+237.3))
50 E2=610.78*EXP((17.2693882*TW)/(TW+237.3))
60 E3=E2-G*(1+1.15E-3*TW)*(TD-TW)
70 VPD=E1-E3
75 VPD=VPD/1000
80 RH=100*(E3/E1)
90 PRINT "VPD = ";VPD;"  RH=";RH
100 GOTO 10
```

NOTE; °C=(°F-32)/1.8